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New records of six *Pyrenula* species from China

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Abstract—*Pyrenula mastophora*, *P. micheneri*, and *P. thailandica* are reported for the first time from China; and *P. bahiana*, *P. complanata*, and *P. platystoma* are reported for the first time from mainland China. Descriptions, illustrations, and distributions are given for each species.

Key words—Asia, lichen-forming fungi, *Pyrenulaceae*, taxonomy

Introduction

The conserved genus *Pyrenula* Ach. (*Pyrenulaceae*, *Ascomycota*) was described by Acharius (1814). In a world key of *Pyrenula* species, Aptroot (2012) accepted 169 species out of the c. 745 named taxa in the genus. Since then, many new species of *Pyrenula* have been described and the genus now comprises c. 226 species (Ingle & al. 2018).

Pyrenula comprises crustose lichens typically growing on smooth, shaded bark (Aptroot 2012). It is characterized by a UV– or UV+ yellow thallus, perithecioid ascomata, an occasionally inspersed hamathecium, unbranched filaments, and distoseptate or (sub)muriform brown mature ascospores, and old spores with or without orange oil granules. Aptroot & al. (2013) noted that

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the presence of orange reddish granules in over-mature spores is an important character that has made it much easier to recognize undescribed taxa.

In this paper we contribute to the knowledge of *Pyrenula* in China by providing fundamental data and reliable results in preparation for the Lichen Flora of China. We have identified three species new to China—*Pyrenula mastophora, P. micheneri,* and *P. thailandica*—and report for the first time three species from mainland China—*P. bahiana, P. complanata,* and *P. platystoma*.

Materials & methods

The specimens studied are preserved in Lichen Section of Botanical Herbarium, Shandong Normal University, Jinan, China (SDNU). The morphological and anatomical characters of the specimens were examined under a COIC XTL7045B2 stereo-microscope and an Olympus CX41 polarizing microscope. Unless otherwise indicated, sections were mounted in tap water (unless otherwise indicated); measurements were made in tap water or water enhanced with KOH. Lichen substances were identified using standardized thin layer chromatography (TLC) with system C (Orange & al. 2010). The lichens were photographed using Olympus SZX16 and BX61 microscopes and an Olympus DP72 camera.

Taxonomy

Pyrenula bahiana Malme, Ark. Bot. 22A(11): 26 (1929) Fig. 1a–d

Thallus corticate, brownish to olive green, with pseudocyphellae, thallus UV–. Perithecia solitary, subglobose, immersed to erumpent from the substratum, often partly or mostly covered by thallus, 0.5–0.7 mm diam. Perithecial wall with crystals, up to 100 µm thick, often not fully carbonized. Ostiole pale, apical. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 8/ascus, grey brown, irregularly biseriate, 3-septate, fusiform with pointed ends, 27.5–30 × 10–15 µm, lumina angular to usually somewhat rounded, all lumina separated from the exospore by a thick endospore layer, old ascospores filled with red-orange oil. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimens examined: **China**. **Guizhou**, **Jiangkou**, Mt. Xiaoding, alt. 900 m, on bark, 4 Apr. 2016, Xiang-Xiang Zhao 20160694 (SDNU); alt. 850 m, on bark, 2 Apr. 2016, Xiang-Xiang Zhao 2016080 (SDNU).

Distribution—Pantropical (Aptroot 2012). New to mainland China, but previously reported from Taiwan (Aptroot 2003).

Comments—*Pyrenula bahiana* is characterized by the thallus with white pseudocyphellae, distoseptate ascospores with three septa, and over-mature

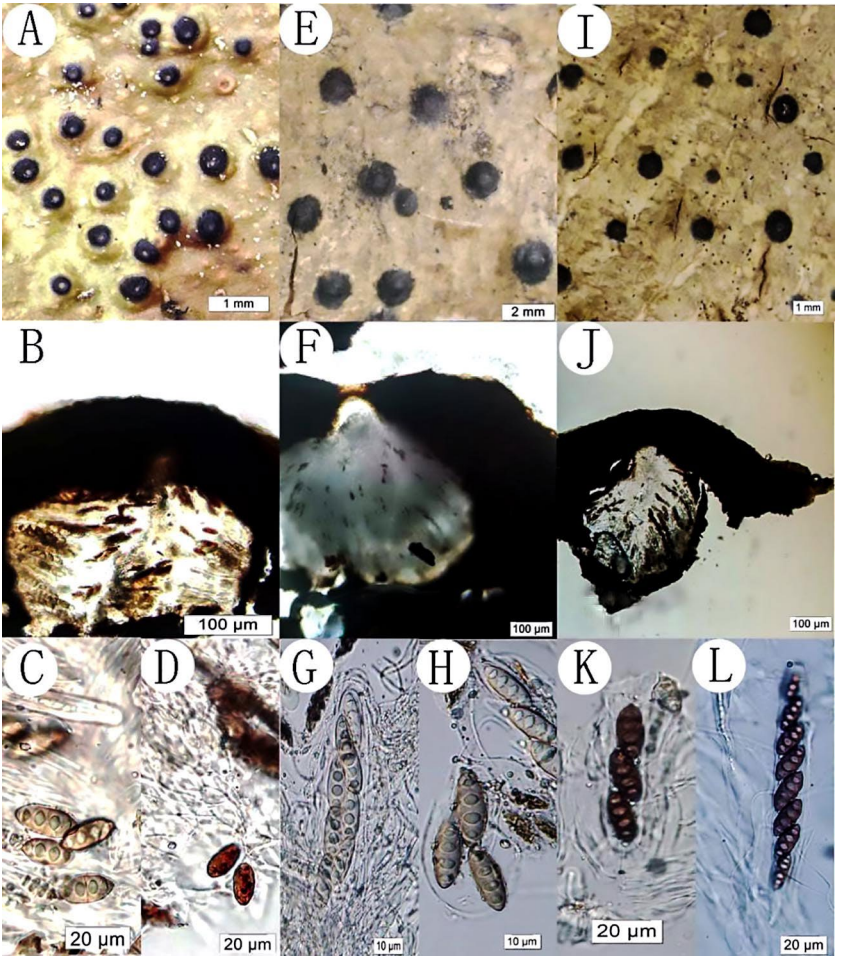

FIG. 1 ***Pyrenula bahiana*** (Zhao 20160694, SDNU). A: thallus with ascomata and pseudocyphellae; B: transverse section through ascoma; C: ascospores; D: over-mature spores with red-orange oil. ***Pyrenula complanata*** (Wang 20107042, SDNU). E: thallus with ascomata; F: transverse section through ascoma; G: ascus; H: ascospores. ***Pyrenula mastophora*** (Li 20110618, SDNU). I: thallus with ascomata; J: transverse section through ascoma; K: ascospores; L: ascus with 8 ascospores.

spores containing red-orange oil. It is closely related to *P. thailandica*, which has larger ascospores (37.5–42.5 × 15–17.5 µm). Our specimens are similar to the *P. bahiana* protologue description, except that the holotype has larger (29–38 × 13–18 µm) ascospores (Ingle & al. 2018).

Pyrenula complanata (Mont.) Trevis., Spighe e Paglie: 17 (1853) Fig. 1e–h

Thallus corticate, pale brownish, without pseudocyphellae, thallus UV–. Perithecia mostly simple, only aggregated as by chance when crowded, erumpent from the substratum, perithecia subglobose and spreading laterally, 0.9–1.4 mm diam. Perithecial wall <225 µm. Ostiole black, apical. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 8/ascus, grey brown, 3-septate, ellipsoid with rounded ends, 30–32.5 × 10–12.5 µm, end lumina separated from the exospore by a thick endospore layer, lumina angular. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimens examined: **China**. **Guangxi**, **Laibinjinxiu**, Mt. Shengtang, alt. 1400 m, on bark, 8 Nov. 2010, Hai-Ying Wang 20107042 (SDNU). **Fujian**, **Longyan**, Mt. Huanglianyu, alt. 600 m, on bark, 2 Apr. 2010, Xing-Ran Kou 20105891 (SDNU). **Yunnan**, **Jingdong**, Mt. Ailao, Dujuanhu, alt. 2500 m, on bark, 5 Aug. 2017, Rong Tang & al. 20170335 (SDNU).

Distribution—Pantropical (Aptroot 2012). New to mainland China, but previously reported from Taiwan (Aptroot 2003).

Comments—*Pyrenula complanata* is characterized by the thallus lacking pseudocyphellae and distoseptate ascospores with three septa. It is closely related to *P. media*, which has shorter ascospores (24–29 µm) and a thicker thallus (Aptroot 2012). Our specimens are closely similar to the *P. complanata* protologue description (Montagne 1843).

Pyrenula mastophora (Nyl.) Müll. Arg., Flora 66: 426 (1883) Fig. 1i–l

Thallus corticate, pale brownish, without pseudocyphellae, thallus UV–. Perithecia simple, solitary, erumpent from the substratum, 0.7–0.9 mm diam. Perithecial wall up to 200 µm. Ostiole black, apical. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 8/ascus, grey brown, 3-septate, ellipsoid with rounded ends, 25–27.5 × 10–12.5 µm, Central lumina much wider than long, end lumina separated from the exospore by a thick endospore layer. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimens examined: **China. Guangxi, Baise**, Tianlin, Mt. Cenwanglao, alt. 2000 m, on bark, 23 Mar. 2011, Lin Li 20110618 (SDNU). **Guizhou**, **Kaili**, Mt. Leigong, alt. 2130 m, on bark, 1 Nov. 2009, Zun-Tian Zhao (SDNU).

Distribution—Pantropical (Aptroot 2012). New to China.

Comments—*Pyrenula mastophora* is characterized by the thallus without pseudocyphellae, distoseptate ascospores with three septa and wide central

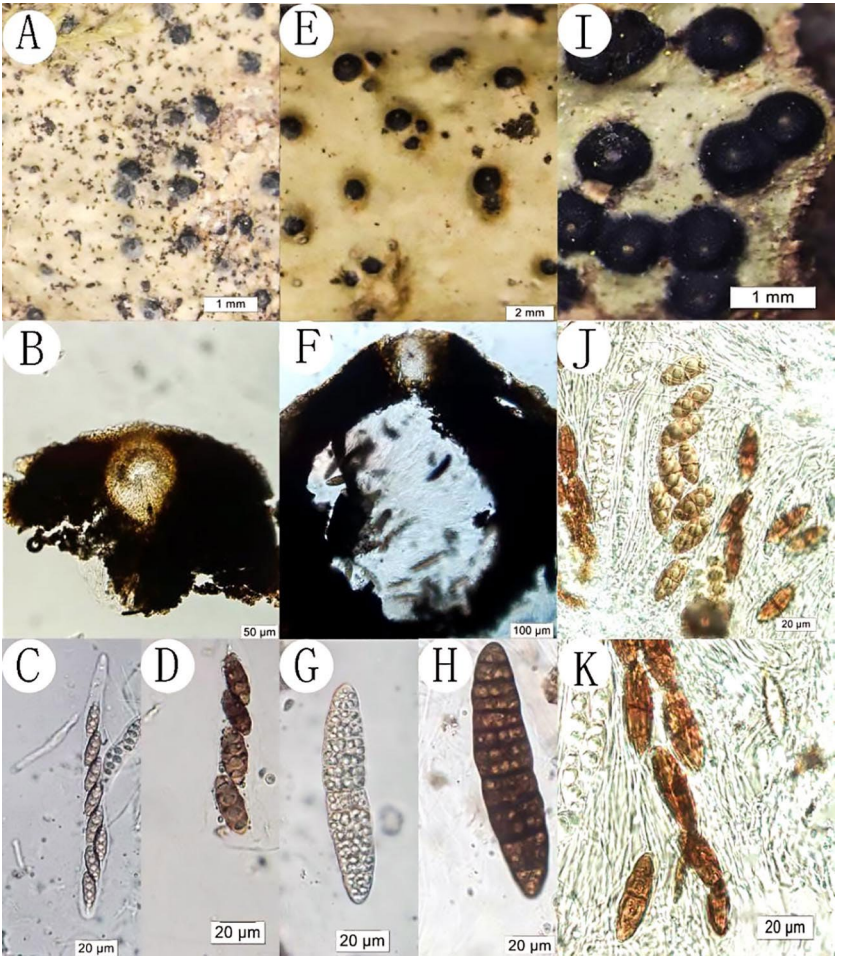

Fig. 2 ***Pyrenula micheneri*** (Li 20106097, SDNU). A: thallus with ascomata; B: transverse section through ascoma; C: ascus; D: ascospores. ***Pyrenula platystoma*** (Tang & al. 20171074, SDNU). E: thallus with ascomata; F: transverse section through ascoma; G: Immature ascospore; H: mature ascospore. ***Pyrenula thailandica*** (Wang 20102341, SDNU). I: thallus with ascomata and pseudocyphellae; J: ascospores; K: over-mature spores with red-orange oil.

lumina, and non-conical ascomata. It is closely related to *P. quassiicola*, which has more or less rounded central lumina and often possesses pseudocyphellae. Our specimens match the *P. mastophora* protologue description, except that the holotype has conical ascomata (Aptroot 2012).

Pyrenula micheneri R.C. Harris,
Mem. New York Bot. Gard. 49: 96 (1989) Fig. 2A–D

Thallus corticate, pale brownish to olive green, without pseudocyphellae, thallus UV–. Perithecia simple, only aggregated as by chance when crowded, immersed to erumpent from the substratum, often partly or mostly covered by thallus, perithecia subglobose, 0.4–0.6 mm diam. Ostiole pale, apical, with numerous crystals around ostioles. Perithecial wall with crystals, <150 µm. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 8/ascus, grey brown, 3-septate, ellipsoid with rounded ends, with angular diamond-shaped lumina, 22.5–27.5 × 7.5–10 µm, end lumina separated from the exospore by a thick endospore layer. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimen examined: **CHINA. Jiangxi, Jian**, Qianmo, Nanfengmian, alt. 1300 m, on bark, 2 Nov. 2010, Ming Li 20106097 (SDNU).

Distribution—Temperate America (Aptroot 2012). New to China.

Comments—*Pyrenula micheneri* is characterized by a thallus without pseudocyphellae, an apical ostiole, numerous crystals surrounding the ostiole, and distoseptate ascospores with three septa and angular diamond-shaped lumina. It is closely related to *P. pyrgillospora*, which has rounded or quadrangular lumina (Aptroot 2012). Our specimen closely matches the *P. micheneri* protologue description (Harris 1989).

Pyrenula platystoma (Müll. Arg.) Aptroot, Lichenologist 44: 36 (2012) Fig. 2E–H

Thallus corticate, yellowish brown, without pseudocyphellae, thallus UV–. Perithecia simple, only aggregated as by chance when crowded, erumpent from the substratum, often partly covered by thallus, 0.7–1.0 mm diam. Perithecial wall <250 µm. Ostiole pale, apical. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 2/ascus, grey brown, muriform with 8–10 rows, fusiform with rounded ends, 145–150 × 28.5–30 µm. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimen examined: **CHINA. Yunnan, Midu**, Mt. Taijiding, alt. 2650 m, on bark, 8 Aug. 2017, Rong Tang & al. 20171074 (SDNU).

Distribution—Pantropical (Aptroot 2012). New to mainland China, but previously reported from Taiwan as *Anthracothecium oculatum* Müll. Arg. (Zahlbruckner 1940, Lamb 1963, Wang & Lai 1973, Kashiwadani & Kurokawa 1981, Wei 1991), which is a synonym of *P. platystoma* (Aptroot 2012).

Comments—*Pyrenula platystoma* is characterized by the thallus without pseudocyphellae and large muriform ascospores. It is closely related to *P. neosandwicensis*, which has pseudocyphellae (Aptroot 2012). Our specimen matches the *P. platystoma* protologue description, except that the holotype has mostly shorter (80–140(–155) μm long) ascospores (Aptroot 2012).

Pyrenula thailandica Aptroot, Lichenologist 44: 617 (2012) Fig. 2I–K

Thallus corticate, brownish green, with pseudocyphellae, thallus UV–. Perithecia solitary, subglobose, erumpent from the substratum, 0.7–0.8 mm diam. Ostiole pale, apical. Hamathecium not inspersed with oil droplets, filaments unbranched. Ascospores 8/ascus, grey brown, 3-septate, fusiform with pointed ends, 37.5–42.5 × 15–17.5 μm, lumina angular to usually somewhat rounded, end lumina separated from the exospore by a thick endospore layer, over-mature ascospores filled with red-orange oil. Substrate bark.

Chemistry—No chemical substances detected by TLC.

Specimen examined: **China. Guizhou**, **Libo**, Maolan protection zone, alt. 500 m, on bark, 2 Nov. 2009, Hai-Ying Wang 20102341 (SDNU).

Distribution—Eastern palaeotropical (Aptroot & al. 2012). New to China.

Comments—*Pyrenula thailandica* is characterized by the thallus with white pseudocyphellae, distoseptate ascospores with three septa, and old spores with red-orange oil. It is closely related to *P. bahiana*, which has smaller ascospores (25–27.5 × 10–15 μm). Our specimen matches the *P. thailandica* protologue description, except that the holotype has (30–)35–51 × (10–)14–20 μm ascospores (Aptroot & al. 2012).

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